AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 112:239–249 (2000)

Trauma in the Preceramic Coastal Populations of Northern Chile: Violence or Occupational Hazards?

VIVIEN G. STANDEN[1] AND BERNARDO T. ARRIAZA[1,2*]
[1]*Departamento de Arqueologia y Museologia, Universidad de Tarapacá, Arica, Chile*
[2]*Department of Anthropology and Ethnic Studies, University of Nevada, Las Vegas, Nevada 89154-5012*

KEY WORDS Chinchorro; fractures; interpersonal violence; coastal bioarchaeology; warfare

ABSTRACT One hundred and forty-four Chinchorro skeletons, stored at the Museo Arqueológico San Miguel de Azapa in Arica, Chile, were examined to test the following alternative hypotheses concerning skeletal trauma: either observed trauma was a consequence of interpersonal violence, or was the result of work-related accidents. Trauma found in subadults was rare, with 1.8% (1/55) contrasted with 30% (27/89) in the adult population. The location of most adult trauma was the skull with 24.6% (17/69), followed by the upper extremities with 8.7% (7/80), the trunk with 2.9% (2/68), and the lower extremities with the least trauma at 1.1% (1/89). Skull trauma corresponded to well-healed, semicircular fractures, with males being three times more affected than females at 34.2% (13/38) and 12.9% (4/31), respectively. Most fractures were nonlethal, appearing to have been caused by impacts from stones, suggesting interpersonal violence rather than accidents. This study indicates that the egalitarian, maritime, hunter-gatherer Chinchorro culture (circa 4000 years B.P.) may not have lived as peacefully as once thought. Am J Phys Anthropol 112:239–249, 2000.

Traumatic injuries such as fractures, puncture wounds, trepanation, and impacts by foreign objects (e.g., projectile points) constitute excellent skeletal markers for the study of social conflict in prehistoric populations (Merbs, 1989). Generally, trauma in prehistoric populations has been the result of warfare, domestic violence, harvesting or hunting accidents, mutilations, and physiopathological factors that favor fractures, such as senile osteoporosis. In modern Western populations, most traumatic lesions are the result of automobile accidents and warfare (Merbs, 1989; Ortner and Putschar, 1981; Steinbock, 1976).

Several studies of prehistoric populations in different regions around the world have documented trauma in skeletal material (Angel, 1974; Knowles, 1983; Lovejoy and Heiple, 1981; Merbs, 1989; Ortner and Putschar, 1981; Steinbock, 1976; Wells, 1976). Walker (1989) encountered a significant percentage of cranial trauma in prehistoric populations of the California islands. He interpreted this to be the result of fighting over limited resources. Similarly, in prehistoric populations of the Andean region of Chile in San Pedro de Atacama, Arriaza (1992) observed a high incidence of nasal fractures (50%) that he believed were associated with ritual bloodletting. In the South Central Andes where prehistoric mummies and skeletal remains are abundant, there is a paucity of trauma studies. This study of

Grant sponsor: Fondecyt; Grant number: 1950035/1970525.

*Correspondence to: Dr. Bernardo Arriaza, Department of Anthropology, University of Nevada, Las Vegas, NV 89154-5012. E-mail: ben@nevada.edu

Received 10 September 1998; accepted 12 February 2000.

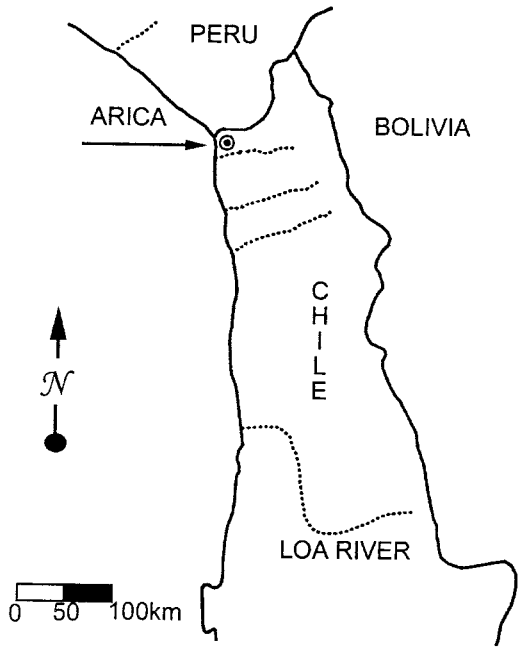

Fig. 1. Location of northern Chile cemeteries from which analyses were made.

the Chinchorros of northern Chile (circa 4000 years B.P.) is an attempt to begin to fill this gap.

The Chinchorros lived in small communities in the coastal valleys that traverse the Atacama Desert (Fig. 1). Their coastal subsistence consisted of shellfish and seaweed gathering, fishing, and hunting for sea lions and birds. These groups complemented their diets with camelids and wild plants such as the edible roots of reeds growing along the delta. The most extraordinary cultural trait of the Chinchorros was their practice of artificial mummification (Allison et. al., 1984; Arriaza, 1994, 1995; Aufderheide et al., 1993; Bittmann and Munizaga, 1976; Núñez, 1983; Schiappacasse and Niemeyer, 1984; Soto, 1987; Standen, 1997; Uhle, 1919).

In previous Chinchorro studies (Standen et al., 1984), several cases of skeletal trauma for both men and women were recorded. Therefore, we decided to systematically test two hypotheses. First, we considered trauma to be primarily the result of interpersonal violence, such as warfare. Fighting styles and types of weapons are culturally determined (e.g., spears, clubs, or daggers). Thus, if conflict was present, a positive correlation should exist between the types of injuries, how lethal the lesion was, the age of the affected individuals, and the presence of objects used in conflicts. Moreover, if continuous physical violence was present, we would expect males to be more affected than females due to their propensity to take greater physical risks and their use of fighting or physical aggression as a way to solve disputes. From an osteological perspective, we would expect to find high degree of male trauma to the face and cranium from such incidents. Alternatively, trauma is considered the result of Chinchorro subsistence activities. The Chinchorro lifestyle was based on fishing and the gathering of shellfish in a rocky coastal environment. If trauma was the result of accidents during daily activities, then nonlethal traumatic injuries to the appendicular skeleton would be the norm, rather than blows to the head or bones embedded with lithic points. Obviously, many types of minor injuries, such as ligament and tendon damage, may not leave permanent imprints on the skeleton. Since such injuries cannot be observed from the skeletal record, our interpretations may be skewed toward the severe cases which do appear in the skeletal record.

MATERIALS AND METHODS

Of the 144 individuals studied, 89 were adults over the age of 17. The majority of cases consist of skeletons rather than mummies dating to about 4000 years B.P. Forty-six were adult males (51.7%) and 43 were females (48.3%). The remaining 55 individuals, unable to be sexed, include infants, children, and adolescents, who will be referred to as subadults in the following discussions. The sample was drawn from five cemeteries, associated with the Chinchorro culture (Table 1), and all were found within a 5-km area along the coast of Arica in northern Chile (Fig. 1).

Each bone was analyzed separately in order to identify the overall trauma patterns of the Chinchorro people. We looked for 1) type of trauma (fractures, wounds, or dislocations); 2) regions of the body most affected (cranium, superior extremities, inferior ex-

TABLE 1. Chinchorro cemeteries studied

Cemetery	Sample size	Date (years B.P.)	Source[1]
Acha 2–3	5	8970–8120	(1–4)
Maderas Enco	3	4750	(5)
Morro 1	89	5160–3670	(6,7)
Morro 1/6	40	4310–3895	(8)
Playa Miller 8	7	4090	(9–11)
Total	144		

[1] 1, Muñoz et al., 1993; 2, Arriaza et al., 1993; 3, Aufderheide et al., 1993; 4, Standen and Santoro, 1997; 5, Arriaza, 1994; 6, Allison et al., 1984; 7, Standen, 1991; 8, Focacci and Chacón, 1989; 9, Alvarez, 1969; 10, Rivera et al., 1974; 11, Soto, 1987.

tremities, or trunk); 3) bones most affected; 4) side of body most affected (right, left, or both); and 5) prevalence rates based on sex and age (Table 2). It was assumed a relationship existed between the types and causes of skeletal trauma. Fractures resulting from morbid conditions, such as osteoporosis, were excluded from this analysis. Diagnosis of trauma type was obtained through macroscopic observation, evaluation of radiographs, size of the lesion, side affected, and changes in the bone tissue. In articulated cranium the endocranium was inspected, aided by a beam from a flashlight, through the foramen magnum, to determine inner table involvement.

RESULTS

Analyses by age

Subadults. Of the 55 subadults, only one individual showed evidence of trauma, or 1.8% of the sample (1/55). This individual, MEC1, was a male, 16–17 years of age, who had a white, quartz lithic point tip lodged in the second lumbar vertebra (Fig. 2). The projectile tip was lodged in the inferior and anterior border of the vertebral body, pointing downward. It reached the vertebral column via the anterior lower abdomen of the individual. From its location, it is possible to determine that the point perforated vital organs. This, combined with the lack of new bone growth, indicates that the wound was fatal. Obviously this trauma was associated with violence. The body was mummified in the black style. Additionally, the front of the body was painted with alternating red and yellow horizontal bands (Arriaza, 1994). The head, trunk, and upper extremities of this mummy were partially destroyed, allowing for visual inspection of its skeletal structure. In general, healing rates are faster in subadults. Therefore, the low rates of trauma recorded in this age group may not accurately depict the actual level of trauma experienced by subadults.

Adults. In the adult sample, the rate of trauma increased significantly from that of the subadults. Thirty percent (27/89) of the individuals had evidence of trauma, mostly to the skull. Males were three times more affected than females. Three cases had multiple trauma; however, most only had one fracture per individual.

Analyses by anatomical segment of the adult sample

Crania. There was a high rate of fractures to the cranium in comparison to other parts of the body. It was found that 24.6% (17/69) of the adult population manifested some type of healed trauma to the cranium. The distribution of cranial trauma in relation to sex showed significant differences. It was found that 34.2% (13/38) of the males were affected by trauma, in contrast to 12.9% (4/31) for females. This difference was statistically significant ($X^2 = 4.2$, d.f. = 1; $P < 0.05$). The majority of the cranial trauma corresponded to healed, depressed, semicircular fractures, suggesting survival from blows to the head. Fracture lines were visible in many cases, but no signs of bone infection were noted. Because little soft tissue was preserved, there were no cases of soft-tissue wounds detected.

It was not possible to inspect the inner table of two cases (M1T19C1 and M1T28C3) because brain tissue was still present. Apparently, four cases with cranial trauma (M1/6 T22, M1031, M1T22C4, and M1T27C18) have no involvement of the inner table. Perhaps the blows to the head were not sufficiently severe to fracture the inner table, or else some of these cranial lesions could represent dermoid cysts (Kohler and Zimmer, 1968), as suggested by one anonymous reviewer. However, in six cases, bulging and fracture of the inner table were clearly observed (see Table 3).

Of the 17 cases with skull trauma (two having double trauma), 11 cases involved

TABLE 2. Anatomical segment studied and percentages of trauma

Body segment	Sample size	M	F	Individuals with trauma (%) M	Individuals with trauma (%) F	Total % with trauma
Cranium	69	38	31	34.2(13/38)	12.9(4/31)	24.6(17/69)
Upper extremity	80	43	37	2.3 (1/43)	16.2(6/37)	8.7(7/80)
Lower extremity	89	46	43	2.2 (1/46)	0.0(0/43)	1.1(1/89)
Thorax	78	33	35	6.0 (2/33)	0.0(0/35)	2.9(2/68)

Fig. 2. Lithic point in lumbar vertebra; 16 mm in height and 13 mm in basal diameter, with thickness of 6 mm (case Maderas Enco C1, subadult male).

the facial bones, including the nasal, maxillary, zygomatic, mandible, and frontal bones (Fig. 3), with the other eight cases involving bones of the cranial vault. To facilitate our analyses, the frontal bone was included as part of the face, although anatomically, it is a bone of the neurocranium. Of the eight cranial bones affected, six had trauma in the parietal bones (Figs. 4, 5a,b), and two had trauma in the occipital area. Of the six cases with trauma to the parietals, all cases involved the left parietal. In the occipital, trauma affected the middle of the bone. We observed seven facial fractures located on the left side, two on the right side, and two in the middle of the face. Apparently, only one case (M1/6 T4) died as a result of a blow to the head. The remaining individuals with cranial fractures showed signs of bone remodeling and healing, suggesting survival (Table 3).

Upper extremities. As a group, 8.7% (7/80) of the individuals had appendicular trauma. We noticed that adult females were significantly more affected by trauma (fractures) to the upper extremities (ulna and radius), with 16.2% (6/37) as compared to 2.3% in males (1/43) ($X^2 = 4.8$, d.f. = 1, $P < 0.05$). The bones affected in the females corresponded to four ulnae and two radii. Three females had "parry fractures" in the diaphysis of the ulna (two lefts and one right). Two of the three females with parry fractures had a nonunion of the broken bones, probably due to failure of callus formation (Fig. 6). The fourth female case corresponded to a fracture of the styloid process of the left ulna. The remaining two females sustained fractures involving the diaphysis of the radius (Fig. 7a,b). The male case affected corresponded to a fracture affecting his right radius.

Lower extremities. In the inferior extremities the rate of trauma was only 1.1% (1/89). Males had 2.2% (1/46), while females had 0% (0/43). The femur of one adult male presented severe trauma with reaction and growth of osseous tissue, localized on the posterior surface of the inferior half of the diaphysis (Fig. 8). Most likely, this trauma was the result of a compound fracture with associated infection.

Trunk. The rate of trunk trauma was only 2.9% (2/68) (Table 3). Males had 6.0% (2/33), while females had 0% (0/35). The first case (M1T16B) was an adult male who had trauma present in the right acromium and a healed depression fracture in two rib fragments. The etiology of the acromium lesion (measuring 19 × 12 mm) was uncertain. The hole was probably an abscess derived from a compound fracture or the result of an injury with a pointed object (Fig. 9a,b). Also, both the spine of the scapula and the medial border had severe and irregular bone growth. Another possibility is that some of the postcranial trauma was accidental because of a fall.

The second case (Acha3 C1), an adult male, sustained a bilateral healed fracture to his first ribs. The left rib displayed bone

TABLE 3. Synthesis of trauma cases

Site-tomb	Age	Sex	Bones affected	Type of trauma
M1T031	30–35	M	Left frontal	Healed depression fracture, 20 × 24 mm, mild. Normal inner table.
M1/6T22	30–35	M	Left frontal	Healed depression fracture, circular, 17 mm, mild. Normal inner table.
M1T1C4	30	M	Left nasal, maxilla, and malar	Healed fracture.
M1T22C5A	40	M	Left nasal and left frontal	Healed depression fracture, 20 × 10 mm. Severe, inner table affected.
M1T28C13	40	M	Left frontal (orbit)	Healed depression fracture, severe. Brain tissue covers inner table.
M1/6T4	40	M	Left frontal (orbit) and left parietal	Fresh fracture with sharp object, 10 × 45 mm. Normal inner table, but parietal has perimortem fracture. Probably killed.
M1T28C2	35–40	M	Left parietal	Healed fracture with sharp object, 15 × 12 mm. Severe, inner table affected.
M1T28C22	37–40	M	Left parietal	Healed fracture with sharp object, 15 × 25 mm. Severe, inner table affected.
M1T27C18	37–40	M	Left parietal	Healed depression fracture, circular, 22 mm, mild. Normal inner table.
Acha3C4	25–30	M	Left temporal and parietal	Healed depression fracture, 41 × 30 mm. Severe, inner table affected.
			Maxilla and palatines	Healed fracture. Loss of first right incisors.
M1T19C1	20–22	M	Occipital	Healed depression fracture, 30 × 23 mm, mild. Brain tissue covers inner table.
M1T22C4	24–26	M	Occipital	Healed depression fracture, 25 × 20 mm, mild. Normal inner table.
M128C3	35	M	Left mandible (body)	Healed fracture with sharp object, 5 × 8 mm, severe.
Acha3C1	30–35	M	Ribs	Healed fracture of first ribs. Right rib with nonunion.
M1T16B	30–35	M	Left lower ribs	Healed depression fracture, mild, 9th (?) and 11th ribs.
			Right scapula, acromion	Lesion 12 × 19 mm in acromion and irregular spinal border.
Maderas Enco C1	15–16	M	Second lumbar vertebra	Tip of lithic point embedded in vertebra.
M1/6TMII	Adult	M	Left femur	Infectious process on diaphysis, probably due to compound fracture or injury.
M1/6T7	25–30	M	Right radius	Healed fracture, distal end.
M1T28C9	20–25	F	Right frontal	Healed depression fracture, 25 × 10 mm. Severe, inner table affected.
M1/6T38	35–40	F	Nasals	Healed fracture, mild.
M1/6TU1	35–40	F	Right maxilla	Healed depression fracture, circular, 16 mm, mild.
M1T8	30–35	F	Left parietal	Healed depression fracture, circular, 30 mm. Mild, but inner table affected.
M1T032	Adult	F	Left radius	Healed fracture of the shaft, distal end.
M1/6T5	20–25	F	Left radius	Healed fracture of the shaft, distal end.
M1T23C4	35–40	F	Left ulna	Healed fracture of styloid process.
M1T27C8	35–40	F	Left ulna	Unhealed parry fracture, nonunion, distal end.
M1T27C13	35–40	F	Left ulna	Healed parry fracture, distal end.
M1/6T10A	35–40	F	Right ulna	Unhealed parry fracture, nonunion, proximal end.

callus, but the right rib presented a nonunion fracture (Fig. 10a,b).

Weapons

Few weapons have been found with the Chinchorros. Those found were either grave goods or located in shell middens. A brief description of each type follows:

Atlatl or spear thrower. This weapon is characteristic of early hunter-gatherers in the South Central Andes and precedes the development of the bow and arrow. Spear throwers were made of wood and measured between 370–500 mm in length by 20 mm in diameter. At the Morro 1 site, we found five spear throwers fabricated in two main

Fig. 3. Healed fracture in the superior external angle of the left orbit. This fracture could have been the result of a direct hit to the face (case M1T22C5a, adult male).

Fig. 4. Healed fracture of the left parietal and temporal (41 × 30 mm), with sinking of the external table. He also has a healed fracture of the maxilla and palate (case Acha3/C4, adult male).

styles: 1) a circular shaft with a carved or bone hook for holding the spear in place; at the proximal end, the spear throwers have a leather loop to insert the thumb for more precise handling; and 2) a concave shaft and attached hook. It is known that spear throwers were used to hunt sea lions because the bones of these animals have been found embedded with lithic points (Schiappacasse and Niemeyer, 1984, their Fig. 30; Standen, 1991). Naturally, spear throwers could have been used against people as well. They have been recorded from many Archaic period sites in northern Chile and appear to have been common tools (Núñez, 1963; Rivera and Zlatar, 1982).

Harpoon heads. Measuring an average of 20 cm in length, harpoon heads are commonly found in Chinchorro cemeteries. Often, the lithic point is missing from the shaft (Fig. 11a).

Darts or spears. At the Morro site, six dart fragments were found, measuring 87–417 mm in length, with a diameter of 8–13 mm. It is assumed that darts were common, because many fragments have been identified at Chinchorro cemeteries.

Lithic points. These points are commonly found in shell middens; however,

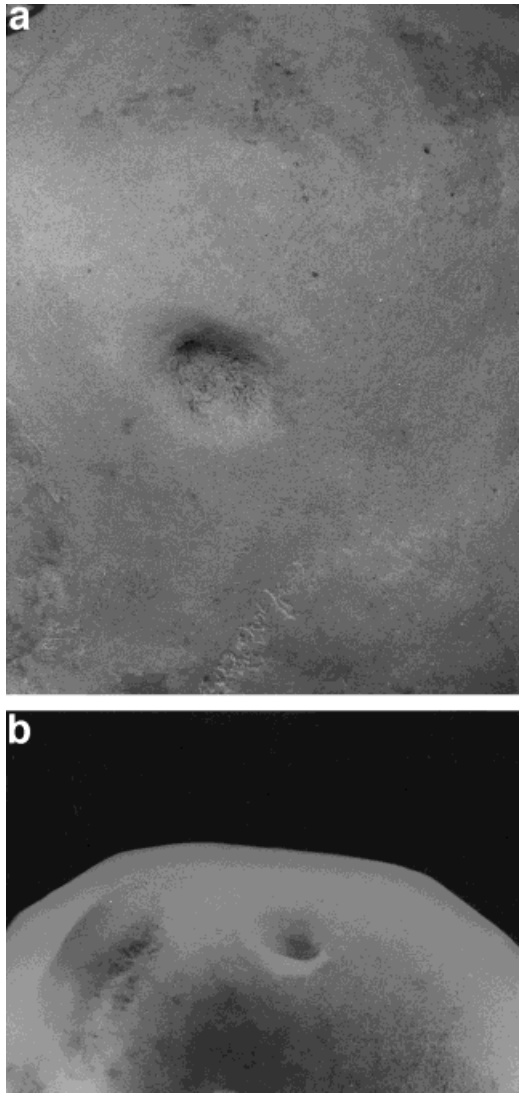

Fig. 5. **a:** Left parietal with a healed fracture (15 × 12 mm). There was destruction of the external table, and the internal table had a small perforation (case M1T28C2, adult male). **b:** Radiograph of same case.

they are rare in cemeteries (see Schiappacasse and Niemeyer, 1984; Standen, 1991). Only two lancelolate points (30 × 10 mm) have been found as part of the overall assemblage of grave goods.

Knife with handle. One knife specimen with a triangular, bifacial blade of chert and a wooden handle as been found. The knife measured 112 mm in length.

Fig. 6. Parry fracture on the left ulna. There was nonunion of the bone (case M1T27C8, adult female).

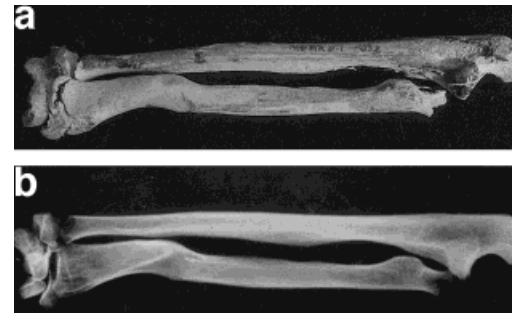

Fig. 7. **a:** Healed fracture of the diaphysis of the radius (case M1032, adult female). **b:** Radiograph of same case.

Lithic knife. A bifacial blade, 80 mm in length, was found in the palm of an adult woman. Uhle (1919) described a similar knife found in an Arica cemetery.

Awl. This sharp instrument (one case) was made of bone, most likely camelid (170 × 20 mm in width). The handle was wrapped with plant fiber cordage, and the shaft had circular marks. The awl was strong enough to have been used as a weapon (Fig. 11b).

DISCUSSION

Of the 28 individuals who had fractures, the majority were healed. Only seven cases did not show signs of healing: three had nonunion fractures (two ulnas and one rib); two had compound fractures (scapula and femur), including one caused by a lithic point impact (vertebra); and one was a mandible injury. The distribution of trauma (fractures and injuries) in relation to body regions varies, but a definite pattern can be seen from the data. The majority of trauma was concentrated in the cranium. Seventeen individuals had trauma to the cranium, seven to the superior extremities, one to the inferior extremities, and three to the trunk.

Fig. 8. Left femur, with an infectious process due to a compound fracture or injury (case M1-6/II, adult male).

Cranium

The majority of cranial trauma was located in the facial bones (frontal, orbit, nose, and maxilla) and parietals, with a high frequency on the left side. No clubs have been found associated with the Chinchorro which might help to explain the semicircular, depressed skull fractures. However, the size of the fractures, their roundness, and the low mortality may indicate that the preferred weapons were cobblestones commonly found along the coast and in riverbeds. We have found no slings in conjunction with the stones; thus, we speculate that the stones were held in bare hands. This could explain the nonlethal nature of the injuries. The fact that cranial trauma was three times more common in men than in women and their clustering on the left side of the face and parietals suggest fighting, or direct blows to the face, rather than random actions or accidents. What was the origin of the Chinchorro skull trauma? Chinchorro fights could have been the consequence of quarrels over natural resources. On the other hand, since their treatment of the dead was so elaborate, it is tempting to hypothesize that the Chinchorro may have included mock fights as part of their funerary rites. Violent funerary fights were common among the Yaghan Indians of Patagonia, as reported by Gusinde (1937). At this time, we do not have enough evidence to fully test such a hypothesis with the Chinchorro. It is also possible the trauma could have resulted from disputes over harvesting grounds, mates, or other personal disagreements. Only three individuals manifested more than one trauma. Therefore, it is clear that violence exercised by members of the Chinchorro society was a product of personal confrontation of low intensity, mostly between men. However, ritual violence cannot be ruled out.

Another analogy that could explain the high rate of skull trauma and its low mortality can be drawn from the Yanomamo Indians, who engaged in stick and machete fights to resolve conflict (Chagnon, 1977, p. 119–120). The Yanomamo fighters would purposely use the side of their machete to avoid cutting or killing their adversary.

Upper extremities

Six women were affected in the forearm (four in the ulna and two in the radius), compared to the one man with a fracture in the radius. The fractures (of the ulna) of two women resemble the “parry fracture,” a condition associated with violence, in which the victim instinctively protects his or her face with the forearm, thus receiving the impact on the ulna. The four remaining forearm fractures of males and females, located one-third from the distal end, could have been the result of either intentional hits or accidental falls.

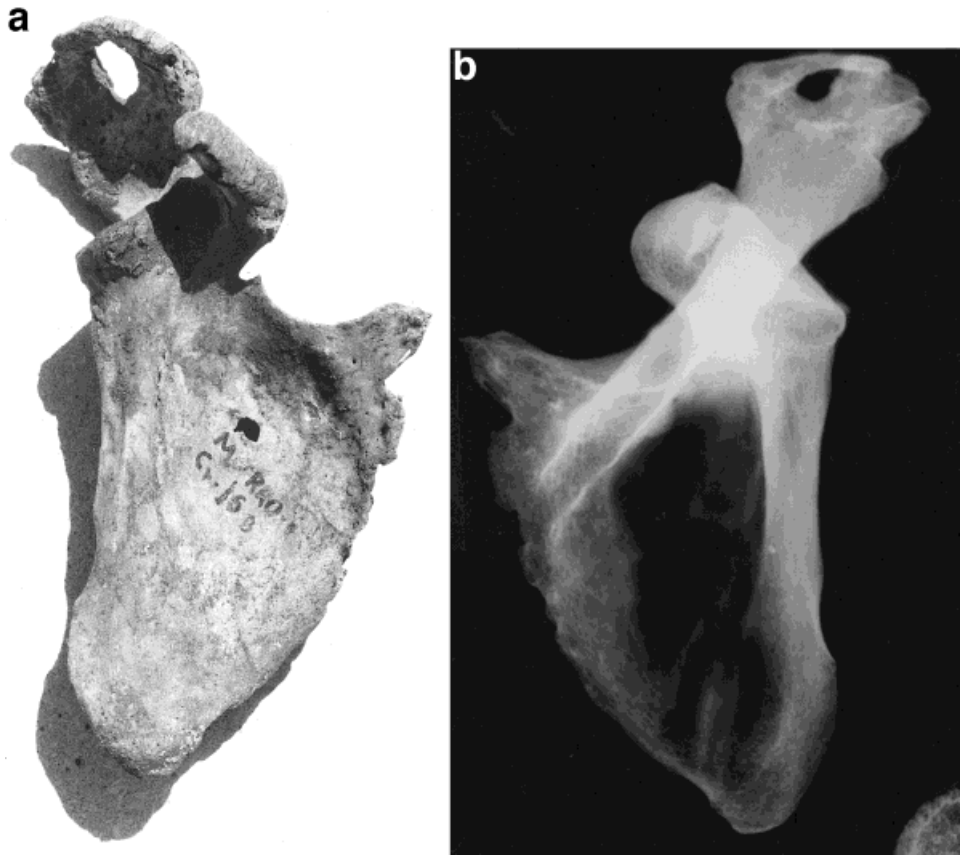

Fig. 9. **a:** Right scapula, with lesion in the acromiun, probably the consequence of a compound fracture or injury (case M1/T16B, adult male). **b:** Radiograph of same case.

Lower extremities

Only one case of leg trauma was recorded. Apparently, the environment in which they lived, even the precarious, rocky coastal areas, was not so hazardous as to provoke fractures during daily activities of fishing and collecting marine foods. However, damage to the soft tissue such as to ligaments and tendons was probably present. Unfortunately, there is no way to test this.

Trauma to the trunk

The three injuries found in the trunk were directed to the scapula, ribs, and vertebrae. One case was that of a healed wound produced by a pointed object or a compound fracture. The other trauma consisted of a bilateral fracture of the ribs and a lithic point in a vertebra. Given that the trauma cases affecting the trunk were received by men, it is likely there is a correlation between this type of violent trauma and men. The presence of an older adolescent male who died from a lithic point injury, also in the trunk, appears to fit into this category of male-type trauma. Thus, situations of violent conflict with murderous intent were apparently very rare, only ranging from 0.7% (1/144) to 2.8% (4/144), including all trunk and a skull trauma.

CONCLUSIONS

The distribution and characteristics of trauma, particularly those of the face and cranium, support the hypothesis that violence among the Chinchorros was the primary cause of trauma rather than work-related or accidental trauma. Moreover, trauma rates were significantly lower for the inferior extremities, implying that the

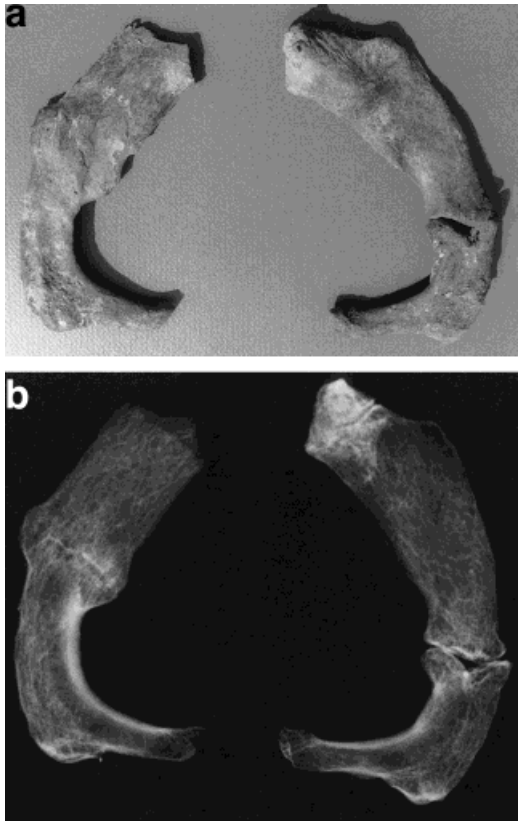

Fig. 10. **a:** Bilateral fractures of the first ribs. The left was healed and the right has a nonunion fracture (case Acha 3C1, adult male). **b:** Radiograph of same case.

rate of accidents affecting the bones in this region of the body was also low. In a few cases, the types of weaponry found in funerary contexts and shell middens of the Chinchorro population might have a direct correlation with the type of trauma identified in the bones. In most cases, however, the weapons were most likely common, round stones held and thrown with the bare hands. Fractures from accidents or falls were less significant and affected adult females in the superior extremities and males in the lower extremities. The fracture pattern may indicate different roles based on gender and age in Chinchorro society.

This bioarchaeological study indicates that the Chinchorros did not always live as peacefully as was once thought. In fact, it seems that one out of every three males received a blow to the head sufficiently severe to cause fracture. They may have had

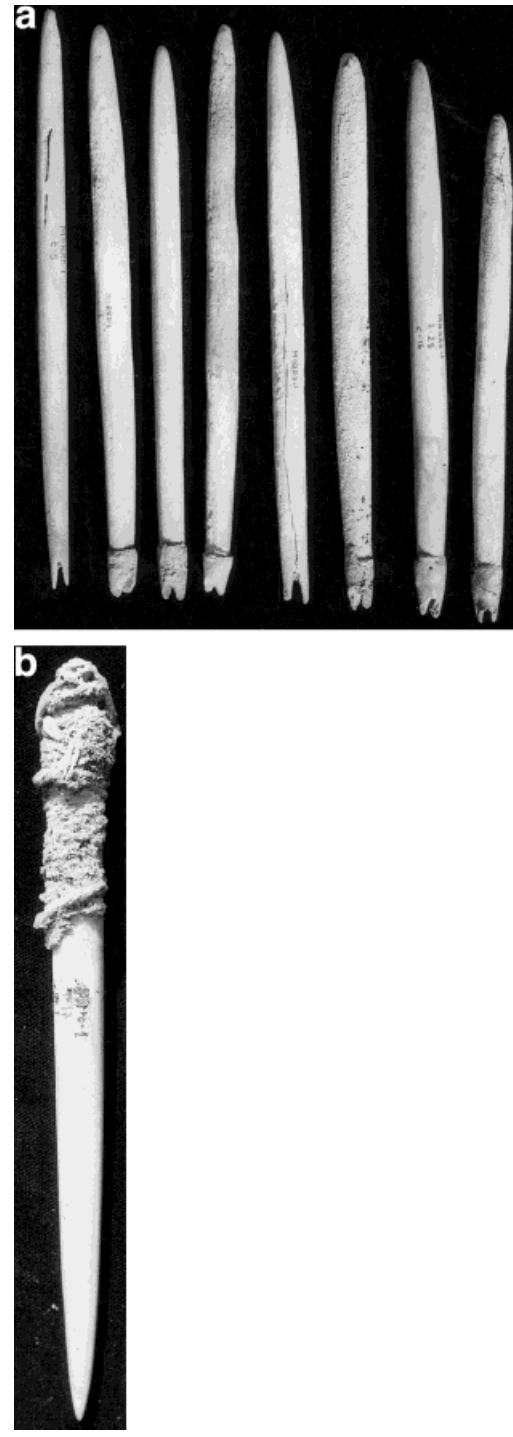

Fig. 11. **a:** Harpoons. **b.** Bone awl.

many more blows that did not cause fracture but that might have been serious enough to cause concussion. Apparently interpersonal violence was not terribly vicious, because only a few individuals died as the result of violently inflicted attacks.

LITERATURE CITED

Allison MJ, Arriaza B, Standen V, Focacci G, Rivera M, Lowestein J. 1984. Chinchorro, momias de preparación complicada: métodos de preparación. Chungara 13:155–173.

Alvarez L. 1969. Un cementerio precerámico con momias de preparación complicada. Rehue 2:181–190.

Angel JL. 1974. Patterns of fractures from Neolithic to modern times. Anthropol Kozlemenyek 18:9–18.

Arriaza B. 1992. Bloody noses, good crops, or ritualistic battles in the Tiwanaku colonies? Paper presented at the Paleopathology and Physical Anthropology Annual Meeting. Las Vegas, Nevada. April.

Arriaza B. 1994. Tipología de las momias Chinchorro y evolución de las prácticas de momificación. Chungara 26:11–24.

Arriaza B. 1995. Chinchorro bioarchaeology: chronology and mummy seriation. Latin Am Antiquity 6:35–55.

Arriaza B, Aufderheide A, Muñoz I. 1993. Análisis antropológico físico de la inhumación de Acha 2. In: Muñoz I, Arriaza B, Aufderheide A, editors. Acha 2 y los orígenes del poblamiento humano en Arica. Arica, Chile: Universidad de Tarapacá. p 47–64.

Aufderheide A, Muñoz I, Arriaza B. 1993. Seven Chinchorro mummies and the prehistory of northern Chile. Am J Phys Anthropol 91:189–202.

Bittmann B, Munizaga J. 1976. The earliest artificial mummification in the world? A study of the Chinchorro Complex in northern Chile. Folk 18:61–92.

Chagnon NA. 1977. Yanomamo. The fierce people. New York: Holt, Rinehart and Winston.

Focacci G, Chacón S. 1989. Excavaciones arqueológicas en los faldeos del Morro de Arica, sitios Morro-1/6 y 2/2. Chungara 22:25–62.

Gusinde M. 1937. Die Yamana: von Leben and Denker der Wassernomaden am Kap Hoorn [The Yaghan: the life and thought of the water nomads of Cape Horn]. Modling bei Wien: Anthropos-Bibliothek.

Knowles AK. 1983. Acute traumatic lesions. In: Hart GJ, editor. Disease in ancient man. Toronto: Clarke Irwin. p 61–83.

Kohler A, Zimmer E. 1968. Borderlands of the normal and early pathologic in skeletal roentgenology. In: Wilk SP, translator and editor. Third American edition. New York: Grune and Stratton. p 185–202.

Lovejoy CO, Heiple KG. 1981. The analysis of fractures in skeletal populations with an example from the Libben site, Otawa County, Ohio. Am J Phys Anthropol 55:529–541.

Merbs CF. 1989. Trauma. In: Iscan MY, Kennedy KA, editors. Reconstruction of life from the skeleton. New York: Alan R. Liss. p 161–189.

Muñoz I, Arriaza B, Aufderheide A, editors. 1993. Acha 2 y los orígenes del poblamiento humano en Arica. Arica: Ediciones Universidad de Tarapacá.

Núñez L. 1983. Paleoindian and Archaic cultural periods in the arid and semiarid regions of northern Chile. Adv World Archaeol 2:161–203.

Ortner DJ, Putschar WG. 1981. Identification of pathological conditions in human skeletal remains. Smithsonian contributions anthropological, no. 28. Washington, DC: Smithsonian Institution Press.

Rivera M, Soto P, Ulloa L, Kushner D. 1974. Aspectos sobre el desarrollo tecnológico en el proceso de agriculturación en el norte prehispánico, especialmente Arica (Chile). Chungara 3:79–107.

Rivera M, Zlataz V. 1982. Las estólicas en el desarrollo cultural temprano prehispánico del norte de Chile. Boletín del Museo La Serena 18:14–34.

Schiappacasse V, Niemeyer H. 1984. Descripción y análisis interpretativo de un sitio arcaico temprano en la quebrada de Camarones. Santiago, Chile: MNHN publicación ocasional no. 41.

Soto P. 1987. Evolución de deformaciones intencionales, tocados y prácticas funerarias en la prehistoria de Arica, Chile. Chungara 19:129–214.

Standen V. 1991. El cementerio Morro 1: Nuevas evidencias de la tradición funeraria Chinchorro (período Arcaico, norte de Chile). Lima: Universidad Católica de Lima, Perú.

Standen V. 1997. Temprana complejidad funeraria en la cultura Chinchorro (norte de Chile). Latin Am Antiquity 8:134–156.

Standen V, Santoro C. 1997. El patrón funerario del sitio Acha 3, norte de Chile. Paper presented at the XV National Archaeology Conference. Copiapó, Chile.

Standen V, Allison M, Arriaza B. 1984. Patologías óseas de la población Morro 1, asociada al complejo Chinchorro: norte de Chile. Chungara 13:197–209.

Steinbock RT. 1976. Paleopathological diagnosis and interpretations. Springfield, IL: Charles C. Thomas.

Uhle M. 1919. La arqueología de Arica y Tacna. Bol Soc Ecuatoriana Estud Hist Am 3:1–48.

Walker PL. 1989. Cranial injuries as evidence for the violence in prehistoric Southern California. Am J Phys Anthropol 80:313–323.

Wells C. 1976. Fractures of the heel bones in early and prehistoric times. Practitioner 217:214–298.